OBSERVARE
Universidade Autónoma de Lisboa
e-ISSN: 1647-7251
VOL. 16, Nº. 2, TD3
Thematic Dossier
Rule of Law, Human Rights, and Institutional Transformation in Times of Global and National Challenges
March 2026

JANUS.NET
e-journal of International Relations

INSTITUTIONAL AND LEGAL SUPPORT FOR STATE MANAGEMENT OF THE BIOENERGY SECTOR'S DEVELOPMENT IN THE CONTEXT OF GLOBAL TRANSFORMATIONS

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Abstract

The relevance of the study is due to the need to transform Ukraine's energy policy in the context of war, global climate challenges and the need for integration into the European energy space. Bioenergy is emerging as a strategic direction for ensuring energy independence, decarbonization of the economy and sustainable development of regions. The purpose of the study is to identify the institutional and regulatory features of public administration in the field of bioenergy in Ukraine in the context of globalization processes. The study uses a systematic, institutional, comparative, analytical and content analysis of legal acts and scientific sources, which ensures a comprehensive approach to assessing the state and trends of the industry. The study found that the Ukrainian model of public administration in the field of bioenergy is in the process of transition from fragmented regulatory support to a systemic policy based on EU standards. The main aspects of legislation harmonization with Directives (EU) 2018/2001 (RED II) and (EU) 2023/2413 (RED III) are defined, the effectiveness of the management process enhancement through decentralization and intersectoral collaboration is described. It is justified that the creation of the multi-level system of the public administration needs a complex of regulatory incentives, support and digitalization of the management. The practical value of the results is in the fact that the proposed conclusions could be adopted to revise the state strategies, form energy clusters, enhance the regulatory framework and increase the institutional capacity of Ukraine in the sphere of renewable energy.

Keywords

Bioenergy, public administration, renewable energy, institutional policy, regulatory framework.

Resumo

A relevância do estudo deve-se à necessidade de transformar a política energética da Ucrânia no contexto da guerra, dos desafios climáticos globais e da necessidade de integração no espaço energético europeu. A bioenergia está a emergir como uma direção estratégica para garantir a independência energética, a descarbonização da economia e o desenvolvimento sustentável das regiões. O objetivo do estudo é identificar as características institucionais e

regulatórias da administração pública no campo da bioenergia na Ucrânia no contexto dos processos de globalização. O estudo utiliza uma análise sistemática, institucional, comparativa, analítica e de conteúdo de atos jurídicos e fontes científicas, o que garante uma abordagem abrangente para avaliar o estado e as tendências da indústria. O estudo constatou que o modelo ucraniano de administração pública no domínio da bioenergia está em processo de transição de um apoio regulamentar fragmentado para uma política sistémica baseada nas normas da UE. São definidos os principais aspetos da harmonização da legislação com as Diretivas (UE) 2018/2001 (RED II) e (UE) 2023/2413 (RED III) e descrita a eficácia da melhoria do processo de gestão através da descentralização e da colaboração intersetorial. Justifica-se que a criação do sistema multinível da administração pública necessite de um conjunto de incentivos regulamentares, apoio e digitalização da gestão. O valor prático dos resultados reside no facto de as conclusões propostas poderem ser adotadas para rever as estratégias estatais, formar clusters energéticos, melhorar o quadro regulamentar e aumentar a capacidade institucional da Ucrânia no domínio das energias renováveis.

Palavras-chave

Bioenergia, administração pública, energias renováveis, política institucional, quadro regulamentar.

How to cite this article
Ianushevych, Iaroslav & Hubanov, Oleg (2026). Institutional and Legal Support for State Management of the Bioenergy Sector's Development in the Context of Global Transformations. *Janus.net, e-journal of international relations*. Thematic Dossier - Rule of Law, Human Rights, and Institutional Transformation in Times of Global and National Challenges, VOL. 16, Nº. 2, TD3, March 2026, pp. 258-276. https://doi.org/10.26619/1647-7251.DT0226.14

Article submitted on 05 December 2025 and accepted for publication on 04 January 2026.

JANUS.NET, e-journal of International Relations
e-ISSN: 1647-7251
VOL. 16, Nº. 2, TD3
Thematic Dossier - *Rule of Law, Human Rights, and Institutional Transformation in Times of Global and National Challenges*
March 2026, pp. 258-276
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INSTITUTIONAL AND LEGAL SUPPORT FOR STATE MANAGEMENT OF THE BIOENERGY SECTOR'S DEVELOPMENT IN THE CONTEXT OF GLOBAL TRANSFORMATIONS

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Introduction

The problem of energy security has become one of the most significant problems of the era due to global climate change, energy crisis and geopolitical instability. In this sense, bioenergy does not simply represent an alternative to fossil fuels in terms of technology, but a perspective of state policy that is both ecological, economical and social regarding sustainability. Specifically, bioenergy development is one of the primary components of the European Green Deal in the European Union that is intended to reach climate neutrality by 2050 (European Commission, 2023; Taylor et al., 2024). In the case of Ukraine, where the country is at war, and energy restructuring is in its deep stage, bioenergy has become a strategic instrument of energy independence strengthening, diversification of energy supply, and development of the region (Kurbatova et al., 2023; Pimenow et al., 2025). It is in this connection that the topicality of the issue is explained by the fact that the current energy policy of Ukraine needs not only to be improved in terms of technology, but a profound institutional reorganization of the public administration. In spite of the fact that there are some strategic documents, including the Energy Strategy of Ukraine up to 2035 and the Concept of Renewable Energy Development, the gap between the regulations and the practice of their fulfillment exists. European researchers note that the effectiveness of the energy transition is based on the quality of the governance mechanisms, the degree of coordination between the state and non-state actors, and the capability of the state to provide transparency and sustainability in the policies (Christou et al., 2024; Proskurina & Vakkilainen, 2024; Buzogány et al., 2023).

The scientific value of this study lies in the combination of European experience in bioenergy management with the Ukrainian context of military and post-war development, which allows us to identify the patterns of formation of a new model of public administration in the field of renewable energy. The theoretical significance is determined by the generalization of institutional and regulatory aspects of energy policy, while the practical importance lies in the possibility of using the results obtained to improve legislation, develop regional energy sustainability programs, and increase the efficiency

of public administration. Despite the significant volume of scientific publications, a number of issues remain underdeveloped. In particular, mechanisms for harmonizing Ukrainian legislation with Directives (EU) 2018/2001 (RED II) and (EU) 2023/2413 (RED III), institutional aspects of interaction between central and regional authorities, and assessment of the effectiveness of management decisions in the context of decentralization require a deeper analysis. The issues of biomass sustainability certification, digitalization of management processes, and integration of scientific developments into the public administration system also remain insufficiently researched (Vasyliev, 2024; Kramar, 2025; Filippova & Stelmashenko, 2024).

The purpose of the study is to identify the peculiarities of institutional and regulatory support for public administration in the field of bioenergy in Ukraine in the context of modern globalization challenges, as well as to characterize the main directions of adaptation of national policy to the standards of the European Union. To achieve this goal, the following tasks have been defined: to systematize key legal acts, analyze the institutional architecture of bioenergy management, assess the level of coherence of Ukraine's state policy, and recommend recommendations for improving the public administration system in the field of bioenergy. To achieve these objectives, a structural and functional analysis of institutional governance mechanisms, a comparative study of the regulatory frameworks of Ukraine and the EU, as well as a generalization of statistical and analytical materials of international organizations such as the European Commission, the European Environment Agency (EEA) and the Energy Community Secretariat were conducted.

Thus, the study aims to fill in the existing gaps in the national scientific debate on the integration of bioenergy development policy into the broader context of public administration. The scientific novelty of the work is an attempt to form a holistic concept of public administration of bioenergy as a multilevel system that combines regulatory, investment, and socio-environmental components. The achieved results can not only increase the knowledge of the institutional relations in energy reforms, but also can provide the practical principles of how to modernize the social policy on sustainable development. Such an analytical framework could be used in the future to build on the basis of an interdisciplinary research that would yield the models of successful public administration in the context of energy transition and post-war recovery of Ukraine.

Literature review

The available scientific literature demonstrates increased importance of bioenergy as the material component of the energy transition that guarantees decarbonization, energy security and development of the region. European scientists focus on the connection between the sustainability policy, bioeconomy, and the regulation of the bioenergy management (Feindt et al., 2020; Buzogány et al., 2023; Proskurina & Vakkilainen, 2024; Taylor et al., 2024). They highlight the necessity to unite environmental requirements and market tools to provide the successful elaboration of the sector within the framework of the European Green Deal. The regulatory and institutional aspects of governance are the subject of recent studies on alignment of national policies to EU Directives (Vasyliev, 2024; Kramar, 2025; Christou et al., 2024; Dadi et al., 2025). Much

effort is devoted to the influence of the war in Ukraine on changing the energy policy and shifting towards renewable sources of energy (Kurbatova et al., 2023; Ciot & Butișcă, 2025; Pimenow et al., 2025; Winkler et al., 2024). The articles have highlighted that bioenergy is not only a part of environmental security, but also in economic recovery and decentralization of energy provision. The connection between sustainable development principles and environmental risk management is also critical to the governance of bioenergy because the state policy development should address the ecological safety principles in the context of large agricultural farms (Sumets et al., 2022). Another important detail that researchers point to is the fact that the institutional basis of sustainability-oriented energy management is the integration of economic and environmental elements into the practicum of the public administration (Voronina et al., 2024). Simultaneously, the emergence of bioenergy digital governance is also burdened with a specific legal and informational security system that is a precondition of successful coordination of actors of the state and the private sphere (Bondarenko et al., 2022).

Some of the authors examine the potential of biomass, biogas, and biofuels as instruments of attaining sustainable development. The researchers add that the effectiveness of the utilization of bioresources is conditional upon the combination of the governance systems, technological advances, and financial opportunities (Guo et al., 2025; Mensah et al., 2025; Sulis et al., 2025; Millinger et al., 2025). Comparative evaluations on the EU level and the Ukrainian level indicate that the application of European standards in the national policy needs more institutional coordination and greater transparency of the sustainability certification processes (Filippova & Stelmashenko, 2024; Vaskina et al., 2025; Strelkowski, 2025; Thomas, 2024). Scientists are also interested in the international tendencies of bioenergy development involving the integration of digitalization, efficiency in logistics, and intelligent governance. Specifically, Baasch (2021), Balanay and Halog (2024), Daneshmandi et al. (2022) incorporate bioenergy supply chain management models in the context of environmental hazards, whereas Reid et al. (2020), Wu and Pfenninger (2022) examine the barriers in introducing bioenergy to the country energy policy. Ukrainian research reveals that the industry has a great potential to guarantee energy independence and minimize CO_2 emission under the conditions of regulatory stability and establishment of public-corporate collaborations (Pryshliak et al., 2022; Kuzior et al., 2021; Filippova & Stelmashenko, 2024; Pimenow et al., 2025).

More of the scientific literature discloses the significance of interdisciplinary approach to the development of bioenergy that relies upon economic, environmental and social management factors. Baasch (2021), Feindt et al. (2020), and Reid et al. (2020) highlight that the development of bioenergy must be premised on the government regulation and market incentives in the same proportion. The specific focus is given to the land use conflicts and biomass in the climate policy context, which needs the creation of more adaptable regulatory tools (Balanay and Halog, 2024; Wu & Pfenninger, 2022; Daneshmandi et al., 2022; Sulis et al., 2025).

The necessity to introduce the digital technologies into the system of the bioenergy industry public administration is also highlighted by the modern international analytical reports. This will enable the optimization of the certification, emission control and reporting processes on biomass sustainability (European Commission, 2023, 2025; EEA,

2025; Taylor et al., 2024). According to Thomas (2024), Strelkowski (2025), and Kurbatova et al. (2023), digitalization helps in enhancing the efficiency of energy flow management, development of transparent monitoring mechanisms, and investment based on innovative financial instruments.

The articles by Vasyliev (2024), Filippo and Stelmashenko (2024), and Pimenow et al. (2025) refer to the details of the legislative regulation and the impact of the state support on the establishment of the sustainable bioenergy policy in Ukraine. The authors point out that it is necessary to establish one coordinating body that would make sure that there is a coherence between the national strategies and the local programs and the European directives. Rather, Kramar (2025) and Vaskina et al. (2025) concentrate on the technical and environmental features of biomethane and biogas development and note the necessity to invest in the technologies of emission reduction and enhance the performance of the agricultural raw materials processing. The issues of regional energy security and decentralization of governance are addressed in Ciot and Butișcă (2025), Kuzior et al. (2021), and Pryshliak et al. (2022), who emphasize the role of local communities in the development of energy clusters and cooperatives. At the same time, researchers Dadi et al. (2025), Mensah et al. (2025), and Millinger et al. (2025) emphasize the global challenges of energy transformation, in particular the need to harmonize international sustainability standards and to develop green justice policies for developing countries.

Thus, the literature review confirms the high level of theoretical and practical development of the topic, but a number of issues remain open. In particular, the mechanisms for integrating digital tools into the public administration of bioenergy and the issue of assessing the socio-economic efficiency of energy clusters in the context of Ukraine's post-war recovery remain underdeveloped.

Methods

The study was based on the analysis of statistical data obtained from publicly available official international sources, including reports of *the* European *Commission,* European *Environment Agency (EEA), Eurostat, and* analytical materials of EERA Bioenergy. To achieve the study's objective, the methods of comparative, analytical, economic and statistical analysis were used to assess the dynamics of bioenergy development in Ukraine and the European Union. Based on official statistics on the share of biomass in the structure of renewable energy, growth rates of biofuel production, solid biomass supply and agricultural biogas potential, generalized tables were constructed for further interpretation of trends. A systematization method was used to compare national and European indicators of bioenergy development, as well as a logical and analytical method to identify patterns and managerial conclusions. Data were selected based on existing open international reports and databases and this ensures that such data is reliable and reproducible.

Results

The existing situation in the development of bioenergy in Ukraine and the European Union can be described as highly dynamic because of the increased interest of the world community to the decarbonization of the economy, energy security, and the shift towards alternative energy sources. In the EU, bioenergy is not considered to be one of the components of energy transformation; however, its part in a wider bioeconomic approach is that which combines industrial, agricultural, and environmental policies. Directive (EU) 2018/2001 on Renewable Energy Sources (RED II) provides strict requirements to the growth of the biomass, biogas, and biofuels respectively in the consumption pattern, predetermining the principles of sustainability and traceability of raw materials. Specifically, mechanisms of institutional governance, specializing agencies, platforms and alliances in the area of bioenergy, making scientific, business and popular policy converge are actively being adjusted by European countries (Christou et al., 2024; Proskurina & Vakkilainen, 2024).

The recent war in Ukraine also highlighted the relevance of bioenergy development after the war, which caused massive losses to the energy infrastructure in Ukraine. Bioenergy has emerged as a significant field in the realization of energy self-sufficiency particularly in the rural population and areas that show biomass availability. Bioenergy is one of the major carriers of decarbonization mentioned by the State Strategy of the Renewable Energy Development till 2035, but the regulatory framework is in pieces. Several governmental programs are oriented at the alignment of laws with the EU Directive, however, the efficiency of the measures to promote the creation of the investment climate by the government and investment is not high yet (Filippova & Stelmashenko, 2024; Vasyliev, 2024). The role of the international programs and donor organizations in the development of the modern architecture of the public administration in this field is important, as they provide financial support to the projects that are aimed at modernizing the bioenergy facilities, implementing monitoring systems, and training the personnel. Specifically, institutional cooperation between the state, local population, and companies that enable the development of energy cooperatives and bioenergy clusters are of significance. This practice creates a multi-level type of governance where coordination of policy, accountability of decision-making and transparency of decision-making are central elements (Kurbatova et al., 2023; Pimenow et al., 2025).

Ukraine is slowly being integrated into the common energy market in the European dimension, where it is necessary to harmonize the structure of governance to the EU standards and introduce the system of data-driven strategic planning and performance indicators. The bureaucratic ability of the government in the bioenergy sector is an important precondition of realizing long-term energy transformation schemes. The quality of the public administration in the sector depends on the interaction of the regulatory frameworks, incentives on investments and participation of the people. According to contemporary researchers, it is only through a systematic approach, which integrates a political will, scientific justification, and a transparent procedures bioenergy will be a true driver of sustainable development (Buzogány et al., 2023; Dadi et al., 2025). Consequently, the analysis indicates that Ukraine is at the phase of shaping its model of the public administration in bioenergy sphere geared towards the European

standards though it requires a greater support of the regulatory coherence, institutional coordination and provision of resources to reach the strategic targets of the energy transition.

The emergence of the state policy in the area of energy transition on the basis of bioresources indicates the wishes of Ukraine to gain energy independence, but, at the same time, to follow the principles of sustainable development and integration into the European energy space. In the current context, the key guidelines for the development of such a policy are the provisions of Directive (EU) 2018/2001 (RED II) and the updated Directive (EU) 2023/2413 (RED III), which set higher targets for the share of renewable energy sources, strengthen the requirements for the sustainability of biomass and stimulate decentralized energy production from bioresources. The Ukrainian regulatory framework is currently undergoing the process of harmonization with European norms, but requires further systematization of state regulatory instruments that ensure the balanced development of bioenergy (Vasyliev, 2024; Kramar, 2025; Proskurina & Vakkilainen, 2024).

The essence of public policy is a combination of strategic planning, regulatory incentives, financial support, and institutional coordination. It is important that the key areas are formed taking into account the European experience, where the approach of "smart governance" prevails – flexible and multi-level governance aimed at achieving decarbonization goals and socio-economic effects for communities (Taylor et al., 2024; Christou et al., 2024). In Ukraine, the emphasis is on creating legal conditions for the development of biofuels, biogas, biomethane, and solid bioresources, but there are barriers to investment, access to finance, and unregulated mechanisms for certifying the sustainability of raw materials. To systematize the main directions of the state policy in the field of energy transition based on bioresources, a generalized table has been prepared (Table 1).

The systematization shows that Ukraine's bioenergy policy is generally in line with European directives in terms of strategic priorities, but retains a number of structural gaps. The greatest efforts are required in the areas of sustainability certification, emissions monitoring, and the development of effective investment incentives. At the same time, there is a positive trend in regulatory adaptation in the area of biomethane, decentralized governance, and community participation in local energy projects. This shows that gradual institutionalization of public administration according to the standards of EU is being carried out, which preconditions the inclusion of Ukraine into the single energy space in Europe.

The development of bioenergy in Ukraine is conditioned by the institutional environment determined by the multi-level system of the public administration which comprises of government agencies, regional institutions, scientific institutions, business structures, and public organizations.

Table 1. Main directions of Ukraine's state policy in the field of bioenergy and their coherence with EU Directives

No.	State policy direction	Main regulatory legal acts of Ukraine	Relevant provisions of EU Directives and international standards	Level of consistency
1	Strategic planning of bioenergy development	Energy Strategy of Ukraine until 2035; Concept of Renewable Energy Development (2020)	RED II, RED III – Strategic goals to increase the share of bioenergy in the overall energy balance	High
2	Regulatory and legal framework for biomass sustainability	CMU Resolution No. 1002 (2021) "On Approval of the Procedure for Determining the Sustainability of Biofuels"; Law "On Alternative Energy Sources"	RED II – biomass sustainability criteria; ISO 14064, 14067 – carbon footprint standards	Average
3	Financial mechanisms and investment support	Law "On the Electricity Market"; State Strategy for Attracting Investments in RES (2022)	European Green Deal; REPowerEU – incentives for RES investors	Medium
4	Development of biomethane technologies	Law of Ukraine "On Amendments to the Development of Biomethane Production" (2023)	RED III – stimulation of biomethane production for gas networks	High
5	Institutional coordination and decentralization of governance	Law on Local Self-Government; ESCO projects, regional energy programs	RED II – support for local energy initiatives and energy cooperatives	Medium
6	Sustainability certification and emissions monitoring	CMU Resolution No. 227 (2022) on verification of greenhouse gas emissions	RED III, ISO 14065, LCA approaches – mandatory environmental reporting	Low
7	Scientific and technical innovation support for the sector	State Strategy for Innovative Development (2021-2030); Horizon Europe programs	EERA Bioenergy; SET-Plan – R&D in the field of bioenergy	Medium
8	Integration into the European energy area	EU-Ukraine Association Agreement; National Energy and Climate Plan (NECP, under development)	RED III, Fit for 55 – integration of RES markets, decarbonization commitments	High

Source: created by the author on the basis of (Vasyliev, 2024; Kramar, 2025; Christou et al., 2024; Taylor et al., 2024; Proskurina & Vakkilainen, 2024; Pimenow et al., 2025)

The success of such environment is determined by the degree of interaction between the two, openness in decisions making and mutualization of power and functions according to the principles of energy security and sustainable development. European approach to energy governance focuses on network coordination among the institutions, participation

of local actors, and establishing cross-sectoral partnerships to provide the opportunity to implement the overall bioenergy transition policy (Christou et al., 2024; Kurbatova et al., 2023).

The institutional framework of bioenergy in Ukraine is undergoing some changes. The main decision-making centers remain the Ministry of Energy, the Ministry of Environmental Protection and Natural Resources, and the National Energy and Utilities Regulatory Commission (NEURC). However, regional authorities, sustainable development agencies, biofuel producers' associations, public environmental associations, and scientific institutions are also becoming increasingly important as communication intermediaries between the state, business, and society. To visualize the institutional environment and the interaction of key actors in bioenergy development, a generalized structure is presented below (Table 2).

The interaction of public administration entities in the field of bioenergy has horizontal and vertical dimensions. Horizontal interaction is realized through partnerships between the state, business and civil society, which contributes to the formation of "energy ecosystems" focused on local self-sufficiency and the development of innovative technologies. Vertical interaction ensures coordination between central and regional levels of government, directing efforts to achieve energy security, reduce dependence on imported energy and create conditions for sustainable economic growth.

To conclude, the institutional environment of the bioenergy sector in Ukraine is in the gradual process of transforming the administrative command setting to the networked management one, which addresses the requirements of European good governance and offers the principles of openness, responsibility, as well as cross-sectoral cooperation. This preconditions the enhancement of the energy security of the country and its entry into the European energy space.

Within the framework of the contemporary globalization issues – mainly war, energy instability and climate crises, the emergence of bioenergy technologies is a strategic move towards the economic sustainability and energy security. Bioenergy is not only an alternative form of energy, it is also a systemic determinant of socio-economic development because it can provide new labor markets, promote innovation in renewable technologies, as well as ensure the decarbonization of industry and the agricultural sector. Simultaneously, the level of the management decision efficiency in this respect is considerably predetermined by the degree to which the public administration can find a compromise between economic feasibility, environmental protection, and social equity (Dadi et al., 2025; Mensah et al., 2025; Wu & Pfenninger, 2022).

The Ukrainian war has become a significant trigger of reviewing the energy policies: the devastation of infrastructure, increased costs of standard resources, and the necessity of a quick shift to the model of decentralized energy supply has become a reality that proves the role of bioenergy as a survival tool, rather than a long-term modernization (Pimenow et al., 2025; Kurbatova et al., 2023). Meanwhile, the obstacles are increasing, namely, insufficient investment and inadequate logistics infrastructure. Under these conditions, the evaluation of the economic, environmental and social impact of bioenergy technologies acquires a systemic significance since it will be possible to modify the

policies to the new realities of post-war recovery and the tendencies in the world environment. Table 3 summarizes the relevant aspects.

Table 2. Main public administration entities in the field of bioenergy in Ukraine and areas of their interaction

No.	Group of institutions	Key actors	Main functions and powers	Nature of interaction with other entities
1	Central executive authorities	Ministry of Energy; Ministry of Environmental Protection and Natural Resources; Ministry of Economy	Formation of the state policy in the field of bioenergy; development of strategies, legislative acts and support programs	Coordination and regulation of the industry; interaction with international partners
2	Regulatory bodies	NEURC; State Agency on Energy Efficiency and Energy Saving of Ukraine (SAEE)	Licensing of energy production from bioresources; tariff policy; supervision of compliance with technical requirements and standards	Cooperation with producers, local authorities, investors
3	Regional authorities and local governments	Regional and city councils; regional energy agencies	Development of local RES programs, creation of energy clusters, project management at the community level	Decentralized coordination with central authorities; participation in EU grant programs
4	Business and private sector	Energy companies; agricultural enterprises; investors in biogas plants and biomethane projects	Implementation of production facilities; participation in public-private partnerships; technological innovations	Interaction with regulators, financial institutions, and communities
5	Research and educational institutions	Institute of Renewable Energy of the National Academy of Sciences of Ukraine; specialized universities	Conducting research; training of personnel; development of biomass processing technologies	Cooperation with government, business and international research networks
6	Public and international organizations	Bioenergy Association of Ukraine; Energy Community Secretariat; UNDP, USAID, GIZ projects	Expert support, popularization, policy monitoring; attracting international funding	Partnership in strategy development and preparation of recommendations
7	Financial institutions	EBRD, World Bank, Energy Efficiency Fund	Provision of loans and grants for the development of bioenergy facilities; support for innovation	Cooperation with government and business through sustainable financial instruments

Source: created by the author based on (Filippova & Stelmashenko, 2024; Kurbatova et al., 2023; Pimenow et al., 2025; Ciot & Butișcă, 2025; Christou et al., 2024)

Table 3. Economic, environmental and social effects of bioenergy technologies implementation in Ukraine in the context of global challenges

No.	Category of effects	Main manifestations	Potential benefits	Main risks / limitations	Management implications
1	Economic	Increase in production of biofuels, biogas, biomethane; development of local energy enterprises	Reduction of energy imports; creation of jobs; increase in tax revenues	High initial investment costs; market instability; currency risks	Need to stimulate the private sector, attract international financing
2	Environmental	Reduction of CO_2 emissions; utilization of agricultural and household waste; reclamation of degraded land	Reducing the greenhouse effect; improving the environment; replacing fossil fuels	High costs of sustainability certification; risk of monocultures; need to control the balance of ecosystems	Development of an eco-audit system, harmonization with RED II / RED III, ISO 14064
3	Social	Creation of new jobs in rural areas; formation of "green" competencies; increase of energy autonomy of communities	Development of local communities; strengthening of social cohesion; improvement of quality of life	Low level of public awareness; uneven access to resources	Development of training programs and educational initiatives
4	Impact of war and energy crises	Destruction of infrastructure; rising energy costs; decreased energy sustainability	Intensification of energy supply decentralizatio n processes; attraction of donor reconstruction programs	Supply chain disruption; equipment shortages	Development of crisis strategies; state coordination of energy recovery
5	Decarbonization trends and interna-tional commitments	Harmonization with the Paris Agreement, European Green Deal, UN SDGs	Strengthening international cooperation; access to green financial instruments	Mismatch between ambitions and available resources	Need to integrate energy, environmental and social policies

Source: created by the author on the basis of (Dadi et al., 2025; Mensah et al., 2025; Kurbatova et al., 2023; Pimenow et al., 2025; Wu & Pfenninger, 2022; Guo et al., 2025)

The discussion of the above data indicates that the implementation of bioenergy technologies is a multidimensional impact which transcends the energy policy. The economic gains are reflected in the development of new market segments, the energy balance diversification, and region competitiveness. The environmental impact is to mitigate the anthropogenic impact, and this is aligned with global decarbonization objectives, whereas the social impact is to generate more job opportunities and enhance

social resilience of the local communities. Nevertheless, these advantages can be achieved only under the condition of the presence of a stable regulatory regime, efficient financialization, and the all-encompassing administration of citizens. The bioenergy in Ukraine, in this case, can be seen not only as a field of energy, but also as a significant element of national security and national economic restoration after the war.

As Table 4 reveals, the proportion of bioenergy in the renewable energy of the EU and biogas potential in Ukraine indicate the particular size of the sector.

Table 4. Key statistics on bioenergy in the EU and Ukraine

No.	Parameter	Year/period	Value
1	Share of biomass in renewable energy (EU)	2021	59.00%
2	Share of renewable energy sources in final energy consumption (EU)	2023	24.50%
3	Increase in primary supply of solid biomass (EU) 2008 → 2021	2008: 3 336 811 TJ → 2021: 4 454 768 TJ	growth by +33.50
4	Agricultural biogas potential of Ukraine	estimate of ~ 15 438.75 million m³ of biogas per year	equivalent to ~ 8,800.00 million m³ of biomethane

Source: created by the author on the basis of (European Commission, 2025; EEA, 2025; Vaskina et al., 2025) according to the list of references

The table presents some of the most important statistical indicators that present how bioenergy is important in the European Union as well as the future of biogas development in Ukraine. The proportion of biomass in the renewable energy system of the EU is approximately 59 percent that accentuates that it prevails over the other technologies. In the EU, the overall renewable energy has reached 24.5% in 2023, which means the slow shift of the energy mix towards renewable sources (EEA, 2025). During *the* period *2008–2021,* the volume of primary supply of solid biomass in the EU increased from 3,*336,811 TJ* to 4,*454,768 TJ,* i.e. by 33.5%, *which* demonstrates a steady increase in demand for bioenergy resources (European Commission, 2023).

In the case of Ukraine, the potential of agricultural biogas is estimated at approximately 15,438.75 million m 3/per year, which corresponds to approximately 8,800.00 million m 3/per year of biomethane. Such numbers suggest that the industry has big reserves to be developed and that it can somewhat cover the energy import requirements of the country (Vaskina et al., 2025). Considering such statistical data during the study will only make it possible not only to quantify dynamics of bioenergy, but also to justify the decisions taken by the management based on real indicators. On the one hand, it is possible to specify the scale and structure of the market, and, on the other hand, ambitions and restrictions on the situation in the national perspective.

In this way, the analytical component of the study is reinforced by the statistical information of international sources proving that the concept of the public administration

of the sphere of bioenergy must be founded on the combination of objective quantitative characteristics and the strategic forecasting. In this way, the balanced policy of energy transition can be considered, considering the objective trends in the development of bioenergy in the EU and the internal potential of Ukraine (European Commission, 2023; EEA, 2025; Vaskina et al., 2025).

The evolution of the bioenergy sector in Ukraine needs the complex model of the population administration on the foundation of the combination of the regulatory, institutional, and economic elements. The initial one ought to establish a consistent legal environment that would bring predictability to the decision-making of the investors and form a foundation of energy policy over the long run. The provisions of Directives (EU) 2018/2001 (RED II) and (EU) 2023/2413 (RED III) emphasizing the specifications of biofuel certification protocols, bio-mass sustainability, and emission reduction requirements should be recommended as the changes to the national regulatory framework are necessary. The implementation of the integrated environmental monitoring and reporting system according to ISO 14064 and ISO 14067 standards, that will enhance the clarity of the regulatory process and make both national and European control mechanisms harmonized, should also be mentioned (Kramar, 2025; Vasyliev, 2024). The condition behind the success of the reform is to enhance the institutional ability of the government agencies, specifically the State Agency on Energy Efficiency and the Ministry of Energy, through creating interagency coordination councils, enhancing the digitalization of the management process and providing clear information exchange between the state, business, and communities (Christou et al., 2024).

The second aspect that should be enhanced in the public administration is the establishment of a desirable investment climate that can bring in the private capital and foreign financial resources to execute the bio energy projects. It is already recommended to establish a national program "Green Transition Investment Framework" which would integrate a mix of public, as well as, private financial tools to develop the infrastructure of biomethane, biogas and bio fuel. They should also pay special attention to the support of the local communities with the help of soft loans, grants, and tax breaks on decentralized energy initiatives that will add to the energy independence of the region (Taylor et al., 2024; Pimenow et al., 2025). Ukraine needs to implement the mechanisms of involvement in the Horizon Europe and the EERA Bioenergy programs as the part of its integration into the European energy area to conduct the joint research, technological advancement, and experience sharing. This coherence of regulations, institutional coordination, and attractiveness to investment, such an integrated approach would be able to guarantee not only the sustainable development of bioenergy, but also the integration of Ukraine into a single energy architecture of the future in the entire European space.

Discussion

The results indicate that the public administration in bioenergy sector in Ukraine is slowly adopting a fragmented regulatory model towards a systemic policy that is geared towards European standards of sustainable development. This corresponds to the results of Christou et al. (2024), Proskurina and Vakkilainen (2024), and Taylor et al. (2024), who

argue that institutional coherence and strategic planning can be considered as primary factors of a well-developed energy system. Meanwhile, other authors, including Feindt et al. (2020) and Baasch (2021), are of the opinion that over centralization of regulatory processes may lower the flexibility of the energy policy, particularly during the crisis, as they are in need of more involvement of the regional actors and a community in the energy governance processes.

The outcomes of the current research prove that the Ukrainian model of governance is being shifted towards decentralization, which supports the views of Kurbatova et al. (2023) and Pimenow et al. (2025) regarding the significance of horizontal connection between the state, business, and communities. Nonetheless, unlike Wu and Pfenninger (2022), who claim that an institutional stability is a key factor in drawing investments, the Ukrainian situation demonstrates that even during the period of regulatory instability, projects have the opportunity to evolve in the form of versatile partnership and foreign assistance. This implies that legal consistency is not the primary success factor per se, but the degree of adaptive ability of management structures.

The problem of focusing on financial rewards instead of regulation is disputable. Dadi et al. (2025) and Mensah et al. (2025) opine that bioenergy is developed as a result of financial support and the investment mechanisms. But Vasyliev (2024), Filippova and Stelmashenko (2024) point to the fact that, in the Ukrainian situation, the financial incentive is not enough to guarantee the sustainability of the industry in the long term without the regulatory stability. The findings of the given research prove that the synergy of the two strategies – regulatory and investment – is a prerequisite of the sustainable development of the bioenergy industry.

There are also considerable disparities in the ways of evaluating the impact of bioenergy on the environment. Guo et al. (2025) and Sulis et al. (2025) argue that bioenergy definitely contributes to CO_2 emission reductions, while Millinger et al. (2025), Balanay and Halog (2024) draw attention to the risks of monoculture production and carbon offsets that may reduce the real environmental effect. The results of the analysis in this article show that the environmental efficiency of bioenergy in Ukraine depends on the regional specificity of resources and the level of control over supply chains, which is consistent with the findings of Kramar (2025) and Vaskina et al. (2025).

Thus, despite the diversity of approaches, most researchers agree that the future of bioenergy will be determined by the quality of public administration, the effectiveness of regulatory adaptation, and the involvement of civil society. To summarize, the results of this study confirm the need for further research aimed at quantifying the effectiveness of bioenergy projects in the post-war period and developing digital mechanisms for monitoring sustainability within the public administration system.

Conclusions

The study has shown that the development of bioenergy in Ukraine is not only a technological but also an institutional and political process that determines the directions of energy security and post-war recovery of the state. The novelty of the obtained results lies in the systematic substantiation of the relationship between regulatory

harmonization, institutional capacity and public administration in the field of bioenergy. In contrast to previous approaches, the study proves that the effectiveness of reforms depends not so much on the number of legislative acts as on the level of coordination between government agencies, business, and local communities. The practical significance is that the proposed analytical model can be used to formulate a policy of "smart governance" and Ukraine's integration into the European energy space. It has been found that the main challenges remain the low level of digitalization of management processes, the lack of investment mechanisms, and the inefficiency of the biomass sustainability certification system. The weakness of this research is that it does not provide an in-depth empirical data on the areas of Ukraine and this aspect makes it impossible to compare regions in detail. It is recommended in the future to devise quantitative models to determine the energy, environmental and social performance of bioenergy projects, increase the database on the analysis of regional practices and consider digital sustainability monitoring tools that can promote transparency and accountability in energy management.

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